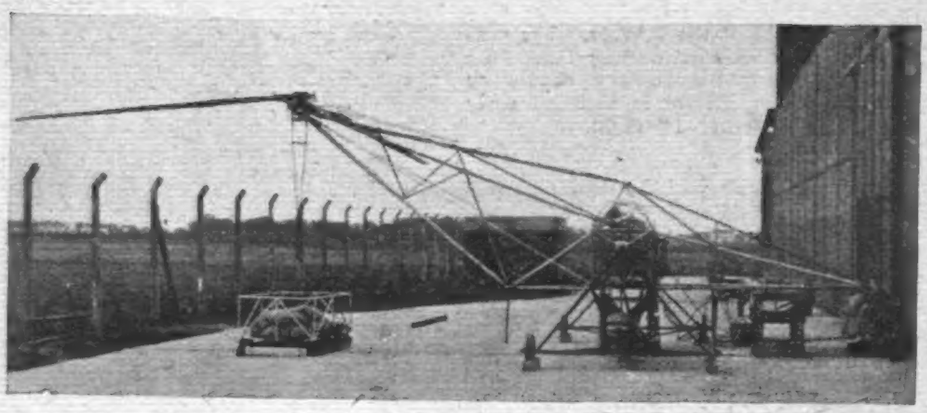


Test rig for single rotor, including an electric motor for the drive. Lift and power required at different speeds were measured simultaneously.

or unofficial helicopter records were in force: distance 1 km; duration about 10 mins.; altitude 18 m. These figures were not very encouraging, and Professor Focke realised that what he had to do was to produce an aircraft worthy of the name, and in order to do this he had to take into account and benefit by all the accumulated experience of those experimenters who had preceded him.

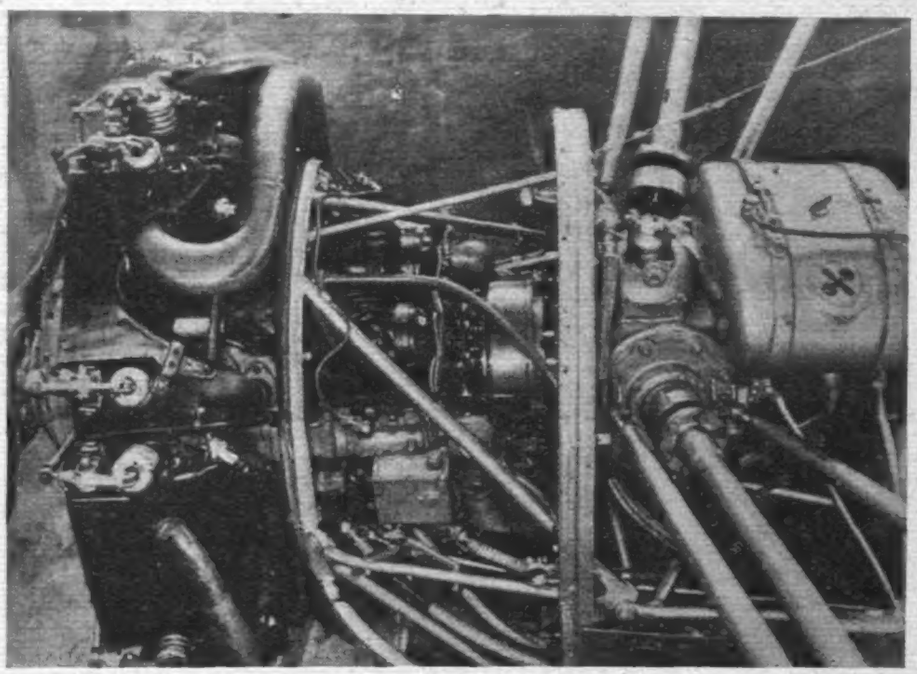
Professor Focke set up, in order of their importance, the following desiderata: Ability to land safely after engine failure; that meant incidence control of the rotor blades. Stability and controllability. General reliability. Simplicity of piloting. As good performance as possible. And last, but not least, the type of construction and general design to be such that people accustomed to ordinary aeroplane manufacture could build the machine.

The design of the rotor blades presented no particularly difficult problems. The three-bladed type was chosen for its efficiency, and its lift was ascertained by means of a model driven by a 3 h.p. electric motor. This model was tested in a wind tunnel, and the forces measured both in the driven condition and when autorotating. Great care had to be taken in making the measurements, particularly on account of the pronounced "ground influence."

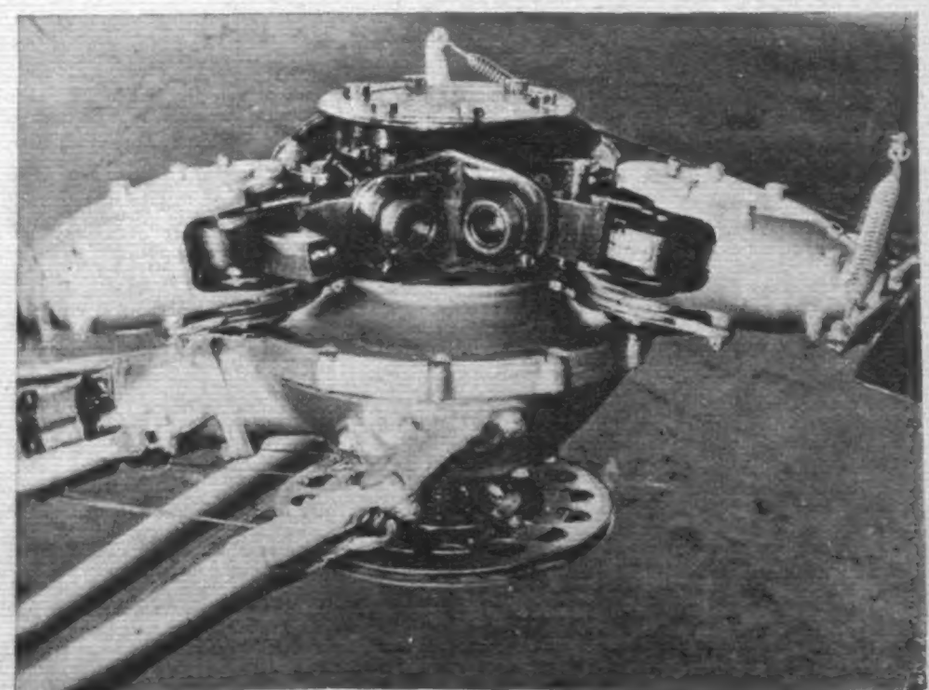
Torque

One of the fundamental problems which actually determines the general design is that of taking care of the torque-reaction from the rotor, which may reach considerable magnitudes. After examining all the rotor arrangements possible, Professor Focke decided upon the side-by-side twin-rotor arrangement as being the most efficient (each rotor working in undisturbed air) and free from the trouble with vibration encountered when one rotor is above the other. The price paid, in the form of aircraft drag, arises, of course, from the outriggers which carry the rotors. By running the two rotors in opposite directions, the torque-reaction is taken care of completely. Another advantage is that the only parts of the aircraft which are in the down-wash from the rotors are the outriggers.

Direct as distinct from indirect control was chosen as being more in keeping with the helicopter ideal and effective during hovering flight. A great deal of time was spent in scheming out an arrangement of control which would not only be natural for the pilot, but which would enable him to change instantly from direct lift to autorotation in case of engine failure. The only control surfaces of orthodox aircraft type are a fin and rudder, and a tailplane with adjustable incidence for trimming purposes. Professor Focke admits that the mathematical calculations connected with stability and control "reached terrifying proportions," but their justification came when, on its very first free flight, the machine reached a height of 400 metres (1,300ft.) and made a three-point landing. What made the procedure even more prolonged was the fact that repeatedly problems cropped up which would not be solved mathematically until certain test data had been obtained. How-



160 h.p. Siemens Sh 14a engine, with clutch and transmission.



Rotor head with blade hinges and incidence control.